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SCHOOL OF AVIATION MEDICINE
RANDOLPH AIR FORCE BASE, TEXAS

MAY 1959

SOME FACTORS AFFECTING THE SPONDEE THRESHOLD IN NORMAL-HEARING SUBJECTS

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May 1959

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SOME FACTORS AFFECTING THE SPONDEE THRESHOLD IN NORMAL-HEARING SUBJECTS

This experiment was designed to investigate the effects of (1) knowledge of test vocabulary and (2) practice in responding to spondee words at threshold intensities on the spondee threshold in normal-hearing subjects.

Results of this experiment were: (1) practice in responding to spondee words at threshold intensities does not influence the spondee threshold in normal-hearing subjects, and (2) normal-hearing subjects given prior knowledge of the test vocabulary yield spondee thresholds 4 to 5 db lower than those yielded by subjects not given such knowledge.

The effects of subject sophistication on auditory test results vary with the particular stimulus being employed to assess auditory acuity. For example, Jerger et al.(1) found that essentially equivalent pure-tone thresholds are obtained for highly sophisticated, highly practiced listeners and for listeners who have had no previous experience in pure-tone audiometric examinations. However, the same experiment suggested that the spondee threshold SPL for "sophisticated" subjects, who were relatively familiar with the spondee vocabulary, was some 5 to 7 db lower than that yielded by inexperienced subjects who were not familiar with the test vocabulary as such. It was found, moreover, that if spondee threshold measurements were repeated in these two groups, the second threshold SPL for the inexperienced subjects was approximately 3 db lower than the initial threshold SPL, while there was essentially no difference in the two thresholds for the sophisticated group.

The above findings led these same investigators (1) to formulate a more extensive experiment utilizing 96 "unsophisticated" normal-hearing subjects between the ages of 18 and 24 years. The design of the experiment allowed the assessment of the effect of prior knowledge of the test vocabulary on the spondee threshold. Prior knowledge of test vocabulary was imparted to half of the subjects by reading the entire list of spondee words to them immediately preceding the measurement of the spondee threshold. The mean spondee threshold SPL for the group given previous knowledge of the test vocabulary was approximately 3 db better than that for the group not given such knowledge.

Since this 3 db improvement could have been due, in part, to knowledge of test vocabulary and, in part, to practice in the task of responding to words at threshold intensities, the present study was designed to isolate the effects of these two variables: (1) knowledge of spondee test vocabulary, and (2) practice in the task of responding to faint spondee words.

APPARATUS

The core of the apparatus used to measure spondee and 1000 cps thresholds consisted of a commercially available speech audiometer (Grason-Stadler, type 162) feeding a PDR-10 earphone mounted in an MX41/AR cushion. All spondee thresholds were obtained by playing portions of recorded List E of CID Auditory Test W-1 through this speech audiometer.

A separate pure-tone source, consisting of a commercially available clinical audiometer (Beltone, model 15-A) was fed through the speech audiometer to the same PDR-10 earphone. This portion of the apparatus was utilized in obtaining thresholds for a pure tone of 1000 cps.

Received for publication on 4 February 1959.

The electrical signal across the earphone was measured periodically with a vacuum-tube voltmeter (Hewlett-Packard, model 400A). The acoustic output of the apparatus was calibrated by means of an ASA type-1 coupler, calibrated condenser microphone (Western Electric, type 640AA), cathode follower (ADC, D5153), and vacuum-tube voltmeter (Hewlett-Packard, model 400A). All speech and pure-tone thresholds reported below are, therefore, expressed as the sound pressure level, reference 0.0002 microbar, developed in an ASA type-1 coupler.

The sound pressure level developed by the earphone at octave frequencies from 125 to 8000 cps was measured before beginning the experimental testing and at three-day intervals throughout the course of the testing. The maximum variation in output over the testing period at the test frequency of 1000 cps was 0.5 db. This variation equaled or exceeded the maximum variation which occurred at any octave frequency from 250 to 4000 cps. However, maximum variations in output of 0.6 and 2.5 db occurred during the testing period at 125 and 8000 cps, respectively. Prior to the experiment, measurements demonstrated that the speech audiometer equaled or exceeded all specifications listed in the American Standard Specifications for Speech Audiometers (2).

SUBJECTS AND PROCEDURE

Three groups of 10 subjects each were selected from the female student body at Northwestern University. The age range of each group was restricted to 18 to 24 years, and no subject was accepted who reported any history of ear pathology, excessive noise exposure, or previous experience as a listener in auditory tests involving speech stimuli. All prospective subjects were screened audiometrically at a hearing level (hearing loss dial setting) of 10 db re: USPHS norm, at each octave interval from 125 to 8000 cps, as well as at 1500, 3000, and 6000 cps. No subject was accepted who failed to respond to any test frequency at the screening intensity in either ear. Only one ear of each subject was used in the collection of the data reported below. The right ear was tested in half of the subjects; the left ear, in the remainder. Subjects accepted for the experiment were assigned to the three experimental groups in a haphazard and nonsystematic fashion.

Each subject was seen in a single experimental session during which three thresholds were measured, the threshold for a 1000 cps pure tone and two separate thresholds for spondee words. The measurement of the threshold for the 1000 cps tone always followed the initial spondee threshold and preceded the second spondee threshold.

Group A (practice only)

One group of 10 subjects, hereafter referred to as group A, was included to test for the effects of practice only. In this group the first spondee threshold was obtained by playing words 1 through 18 of recorded List E of CID Auditory Test W-1. The second spondee threshold was obtained by playing words 19 through 36 of the same recording. The effects of practice alone on the spondee threshold could then be evaluated by comparing the mean threshold obtained in the first test with the mean threshold obtained in the second test.

Group B (practice and possible prior knowledge)

A second group of 10 subjects, hereafter referred to as group B, was included to assess the combined effects of practice and possible knowledge of test vocabulary, prior to the *second* threshold. In this group, the first spondee threshold was obtained by playing words 1 through 18 of recorded List E of CID Auditory Test W-1. The second spondee threshold was then obtained by playing the same 18 words again. The effects of practice plus *possible* knowledge of test vocabulary could then be evaluated by comparing the magnitude of the two mean thresholds thus obtained.

Group C (practice and definite prior knowledge)

A third group of 10 subjects, group C, was formed to evaluate the combined effects of practice and *definite* prior knowledge of test

vocabulary on the spondee threshold. In this group, both spondee thresholds were obtained by playing words 1 through 18 of recorded List E of CID Auditory Test W-1. In addition, each subject was given prior knowledge of the test vocabulary by hearing the first 18 words of this list, in the manner described below, immediately preceding the measurement of the *first* spondee threshold. The effects of *definite* prior knowledge of test vocabulary could then be evaluated by comparing the mean initial threshold for this group with the mean initial thresholds obtained for groups A and B.

All spondee thresholds were obtained by the "up-and-down" method, described in detail by Jerger et al. (1), utilizing 2 db steps of attenuation. This method was chosen in preference to a simpler and less time-consuming clinical procedure because it allowed each threshold to be defined using exactly the same number of stimulus presentations. In other words, each spondee threshold was defined by presenting a series of 18 spondee words using the up-and-down method of threshold measurement. As noted earlier, these 18 words were always either words 1 through 18 or words 19 through 36 of recorded List E of CID Auditory Test W-1.

A clinical procedure utilizing 2 db steps of attenuation was employed to measure each subject's threshold for a 1000 cps pure tone. The procedure employed was the "ascending" technic described in the 1951 revision of the *Manual for School Hearing Conservation Program*, of the American Academy of Ophthalmology and Otolaryngology (3).

The instructions read to subjects in the present study preceding the experimental session were essentially identical to those used by Jerger et al. (1). The only changes were necessitated by the fact that the latter study employed only two test runs, while the present study used three test runs.

In addition to the instructions noted above, which were read to all subjects, the following instructions were read to the "prior knowledge" group immediately before the initial spondee threshold was measured.

> Before the initial word test, I will read a series of 18 two-syllable words at a level which is easy for you to hear. You are to repeat back each word. These words are the same ones that you will later hear in the two word tests; however, they will be in a different order. Since the purpose of this initial reading is to make you familiar with the words, please listen carefully.

The first 18 words of List E of CID Auditory Test W-1 were then pronounced in alphabetic order by monitoring live voice at a level 50 db above the present American norm of 22 db SPL.

RESULTS

Table I summarizes the experimental data. Group A, in which the first spondee threshold was obtained using the first 18 words of recorded List E and the second threshold using the second 18 words of the same recorded list, showed an improvement in threshold acuity of 1.1 db from the first to the second test. This is a very slight difference, and it would seem hazardous to conclude that it resulted from practice in the task of responding to spondee words at threshold intensities. This seems particularly true in view of the essentially equivalent thresholds for the two spondee threshold tests in group C. In this latter group, the two thresholds were obtained using the first 18 words of recorded List E after the subjects had been given previous experience with the test words. The 0.3 db improvement in this group from the first to the second test could hardly indicate an important practice effect.

In group B an improvement of 2.4 db occurred from the first to the second spondee threshold test. The two thresholds in this group were obtained using the first 18 words of recorded List E. This group, it will be recalled, was included to assess the effect of *possible* knowledge of test vocabulary imparted to the subjects during the first spondee test as well as the effects of practice. In view of the relatively small change which occurred

TABLE I

Mean spondee and 1000 cps threshold sound pressure levels and their standard errors for three groups of normal-hearing subjects*

	First spondee threshold	Second spondee threshold	1000 cps
Group A (N = 10) (practice alone)			
Mean threshold SPL	25.9	24.8	9.3
Standard error of mean	1.0	1.3	1.3
Group B (N = 10) (practice and possible prior knowledge)			
Mean threshold SPL	27.0	24.6	10.9
Standard error of mean	1.2	1.1	1.6
Group C (N = 10) (practice and definite prior knowledge)			
Mean threshold SPL	20.9	20.6	10.7
Standard error of mean	1.0	0.6	1.2

*Decibels re: 0.0002 microbar in ASA type-1 coupler.

from the first to the second thresholds in group A and the essentially equivalent thresholds obtained in group C, it seems reasonable to conclude that the improvement noted in group B was due to the knowledge of test vocabulary gained by the subjects as a result of the initial test.

Comparison of both the first and second spondee thresholds obtained in group C, which was given definite prior knowledge of the test vocabulary, with those for group A, which was given no prior knowledge, reveals that group C yielded 4 to 5 db lower threshold SPLs than group A. It seems reasonable to attribute this relatively large difference solely to the fact that group C had been given prior knowledge of the test vocabulary.

The above findings suggest that, at least so far as short-term effects are concerned, practice in the task of responding to spondee words at near-threshold intensities exerts no important influence on the spondee threshold in normal-hearing subjects. Conversely, it would appear that previous knowledge of the spondee test vocabulary has an important effect. Specifically, threshold SPLs as much as 4 to 5 db lower will be obtained from subjects who are given previous knowledge of the test vocabulary than from subjects who are not given this prior knowledge.

These findings have practical implications for the clinician as well as for those concerned with establishing a normative standard for the hearing of speech stimuli. In the routine clinical procedures requiring successive measurements of the speech threshold using spondee words, the initial threshold SPL established may be 4 to 5 db *higher* than succeeding ones unless time is taken to familiarize the subject with the test vocabulary preceding the initial threshold test.

In establishing an audiometric norm for speech, where spondee words are specified as the stimulus, one must apparently be concerned with the extent to which the criterion population is familiar with the test vocabulary. Such concern is necessary because the absolute value of the standard, as well as the relationship between hearing for pure tones and for speech will be influenced rather importantly by the degree to which the criterion population has prior familiarity with the test vocabulary.

SUMMARY

The purpose of this experiment was to isolate the effects of two variables on the spondee threshold in normal-hearing subjects: (1) knowledge of spondee test vocabulary; and (2) practice in the task of responding to spondee words at threshold intensities.

Three groups of 10 normal hearing subjects each were formed. Two spondee thresholds were obtained for each subject in each group, utilizing recorded List E of Auditory Test W-1. Each threshold was obtained with exactly 18 spondee words. In the first group, the initial threshold was obtained using the first 18 words of the same recorded list. In the second and third groups, both thresholds were obtained using the first 18 words of List E. Before measuring the initial spondee threshold in the third group, however, the entire list of 18 spondee words was read to each subject at an easily audible level.

The results of this experiment suggest two conclusions: (1) so far as relatively short-term effects are concerned, practice in the task of responding to spondee words at threshold intensities exerts no important influence on the spondee threshold SPL in normal-hearing subjects, and (2) normal-hearing subjects given prior knowledge of the test vocabulary yield spondee threshold SPLs which are 4 to 5 db lower than those yielded by subjects not given such knowledge. These findings are of practical importance both in routine clinical practice and in establishing an audiometric norm for speech.

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